REMARKS

I. Status of the Claims

Original claims 1-78 were presented in US Patent No. 5,573,648 (the '648 Patent), as originally issued. Claims 79-85 were previously presented in a Preliminary Amendment, along with the request for reissue on July 17, 2003. Claims 86-94 were previously presented in a Second Preliminary Amendment filed August 7, 2007. In the Response to the Office Action filed September 22, 2008, claims 1, 30, 47, 59 and 94 were amended, and claims 95-97 were newly presented.

The Examiner issued a Notice of Non-Compliant Amendment, November 14, 2008, indicating that claims 1, 3-16 and 75 were cancelled in an Ex Parte Reexamination Certificate Issued Under 35 USC 307. Applicants have cancelled claims 1, 3-16 and 75 from the listing of claims presented herein. Applicants have further amended claims 2, 17, 18 and 27 to remove the dependence on now-deleted claims 1 and 14.

Claims 98-113, which depend directly or indirectly from claim 82, have been added.

II. Introduction to the '648 Patent

As discussed in the Reissue Application Declaration by the Assignee, at the time of filing patent application 381,718, which issued as U.S. Patent No. 5,573,648 on November 12, 1996, Applicants failed to claim inventive methods and apparatus disclosed in the specification of the '648 Patent. Applicants filed this Reissue application to remedy such error.

In a May 23, 2007 Decision on Appeal in a Reexamination proceeding of the '648 Patent (Reexamination Application No. 90/006,208) (hereinafter, "the '208 Reexam"), the Board sustained the Examiner's rejection of claims 1, 3-16, 75, 79 and 80. Claims 1, 3-16 and 75 appealed in the '208 Reexam correspond to claims 1, 3-16 and 75 as originally filed in this reissue; claims 79 and 80 appealed in the '208 Reexam correspond to new claims

95-96 filed herewith. The Examiner's allowance of claims 2, 17-74 and 76-78 was confirmed.

In the Response dated September 22, 2008, Applicants amended claims 30, 47 and 59 to better distinguish over the prior art and/or to improve syntax.

Applicants also submitted therewith Dr. Shen's Supplemental Declaration in support of the commercial success and advantages of the claimed invention over the prior art.

The claims of the '648 Patent are directed to gas sensors, such as carbon monoxide sensors, that are operative to sense a gas in ambient atmosphere. The gas sensors include sensing and counter electrodes, each having both electronic conducting material and ionic conducting material, and a protonic conductive electrolyte membrane between and in contact with the sensing and counter electrodes. Certain gas sensors of the '648 Patent do not require a reference electrode. They do not require a bias voltage. They do not require a power source for sensing of the gas. Thus, the life of any battery used in a two-electrode embodiment of the sensors covered by the '648 Patent, *e.g.*, a two-electrode sensor for use as a residential CO sensor, is extended because the battery is only needed to power an alarm.

III. <u>Support for Claims 95-97 and Claims 98-113</u>

Support for claims 95-113 may be found throughout the specification, claims, figures and abstract as originally filed.

Support for claim 95 may be found, for example, at claim 1 of the '648 Patent, at FIG. 5, and at Col. 7, lines 65-66.

Support for claim 96 may be found, for example, at Column 6, lines 2-3.

Support for claim 97 may be found in the claims of the '648 Patent as originally filed.

Support for claims 98-113 may be found throughout the specification and specifically in claims 3-16 and 75 as originally filed.

IV. Oath/Declaration

A new Reissue Declaration in compliance with 37 CFR 1.67(a) was submitted September 22, 2008. This resubmitted Declaration includes the previously inadvertently omitted sheet with the additional inventors named.

V. Cancelled Claims 1, 3-16 and 75

The Examiner indicated that claims 1, 3-16 and 75, which were cancelled by a reexamination certificate USP 5,573,648 C1 issued in reexamination application 90/006,208, have been withdrawn from further consideration based on "current office policy." The Examiner further issued a Notice of Non-Compliant Amendment indicating that Applicants' failure to cancel claims 1, 3-16 and 75 rendered the Response filed September 22, 2008 non-compliant.

Applicants have herewith cancelled claims 1, 3-16 and 75.

VI. Claims 79-94 are Not Broadened Reissue Claims

The Examiner rejected claims 79-94 under 35 USC 251 as being broadened in a reissue application after the two-year statutory period. According to MPEP 1412.03(I), a broadened reissue claim is a claim which is greater in scope than each and every claim of the original patent. Applicants traverse this rejection as follows.

In the preamble of each of claims 79-82, 86-89 and 92, the recitation of "for quantitative measurement of a gas" was changed to "for measurement of a gas." A preamble of a claim is generally not considered to be a limitation to the claim. Specifically, unless it is 'necessary to give life, meaning, and vitality' to the claim, the claim preamble should not be construed as if in the balance of the claim. If the preamble merely states, for example, the purpose or intended use of the invention, rather than any distinct definition of any of the claimed invention's limitations, then the preamble is not considered a limitation and is of no significance to claim construction (see MPEP 2111.02(II), citing to *Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d 1298, 1305, 51 USPQ2d 1161, 1165 (Fed. Cir. 1999)). In this instance, the phrase at issue—"for

[quantitative] measurement of a gas"—is merely a statement of purpose or use, not a structural limitation of the claim.

Further, if the body of the claim fully and intrinsically sets forth all of the limitations of the claimed invention, then the preamble is not considered a limitation and is of no significance to claim construction. In other words, a preamble generally is not limiting when the claim body describes a structurally complete invention such that deletion of the preamble phrase does not affect the structure or steps of the claimed invention (MPEP 2111.02(II), citing to *Catalina Mktg. Int'l v. Coolsavings.com, Inc.*, 289 F.3d 801, 808-09, 62 USPQ2d 1781, 1785 (Fed. Cir. 2002)). In this instance, the body of the claim does not refer back to the phrase at issue, "for quantitative measurement of a gas," and indeed, the phrase could be eliminated from the preamble without affecting the structure of the claimed invention. Thus, although, in general, the removal of a word or term from a claim would result in a broadening of claim scope, such is not the case in this instance.

In claims 86-89 and 92, the phrase "means detects changes" has been changed to "means is capable of detecting changes." At issue is the recitation:

> "whereby, in a positive ambient concentration of said gas, said electrical measurement means <u>is capable of detecting</u> ~~detects~~ changes in said electrical characteristic."

Applicants made these changes to avoid any possible confusion as to process language—there is no difference in claim scope. The terminology "detects" (as recited in the patent claims) means the same as "capable of detecting" (as recited in the reissue claims). For example, saying that "a vacuum being sold vacuums" does not mean that the vacuum being sold is being used right now, but rather that the vacuum is capable of vacuuming. Thus, a recitation that an electrical measurement means is capable of detecting changes is the same as a recitation that an electrical measurement means detects changes. There is no substantive difference in claim scope when amending "detects" to "capable of detecting."

Similarly, in claims 86-89 and 92, the phrase "electrode reacting with the gas" has been changed to "electrode being capable of reacting with the gas." At issue is the recitation:

> "the sensing electrode <u>being capable of</u> reacting with the gas ..."

Again, Applicants made these changes merely to avoid any possible confusion as to process language—there is no difference in claim scope. The terminology "reacting with" (as recited in the patent claims) need not mean that the sensing electrode is *right now, this very instance*, reacting with the gas. This would be an unreasonably narrow construction of the terminology, particularly within the context of an apparatus claim. When the phrase "reacting with" is given a more reasonable meaning, it is clear that the phrase encompasses "being capable of reacting with" (as recited in the reissue claims). Thus, there is no substantive difference in claim scope when amending "reacting with" to "capable of reacting with."

A reissue claim is broader than the original patent claims if the reissue claim includes within its scope any conceivable product or process which would not have infringed the original patent. In this instance, there is no sensor that would infringe the reissue claims without also infringing the original patent claims.

VII. Response to Rejections in the Office Action dated March 20, 2008

As an initial matter, upon further consideration of Dempsey in combination with either Uchida, Vanderborgh or Grot, Applicants have become aware of the following technical conclusions:

a. The Cited Prior Art

Dempsey

Dempsey discloses flooding one side of a solid polymer electrolyte membrane with distilled water. Specifically, a water channel 7, connected to reservoir 1 via hydrated ports 5 and 6, is positioned over an ionically conductive, hydrated SPE bridge 8 formed on the upper surface of membrane 9. (See Fig. 1; col. 4, lines 30-46.) Further, Dempsey expressly discloses that "the surface of the counter electrode and the membrane area around the electrode is flooded." (Col. 4, lines 46-49.)

Dempsey's principle of operation relies on flooding one side of the membrane with distilled liquid water. Dempsey discloses that this flooding of the membrane with distilled water provides "self-humidification," i.e., transport of water in the vapor phase across the

membrane. (Col. 7, lines 50-54, referring to Nolan et al. (US 4,171,253) which discloses, at col. 3, lines 22-26, that "this self-humidifying arrangement is possible in SPE-type gas sensor by maintaining the side of the SPE membrane away from the gas side, i.e., away from the side containing the sensing electrode flooded with distilled water.") Dempsey further discloses that by eliminating the possibility that the membrane will dry out and by providing an ionically conductive, hydrated SPE bridge, the output current from the device is improved. (Col. 3, line 64 to col. 4, line 10.) Thus, Dempsey teaches that flooding one side of the membrane with distilled liquid water is important for its principle of operation.

With respect to the electrodes, Dempsey discloses that the electrodes are each "a bonded mass of particles of a platinum-5% iridium alloy and *hydrophobic* particles such as polytetrafluoroethylene." (Col. 5, lines 29-33; see also, col. 7, lines 25-31; col. 7, line 65 to col. 8, line 4; col. 8, lines 27-29. Emphasis added.) Dempsey further discloses that "the nature and characteristics of an electrode, comprising a mixture of particles of a gas absorbing noble metal bonded with particles of *hydrophobic* material as well as the process for doing so, are described in detail in U.S. Pat. No. 3,432,355 ["Niedrach"] ...." (Col. 8, lines 31-44. Emphasis added.) Niedrach, in turn, discloses that the electrodes are purposely made *hydrophobic* to prevent flooding/drowning[1] of the electrode when in contact with water:

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[1] "Flooding" refers to the penetration of electrolyte into hydrophobic regions of the catalyst layer which should contain only gas. This misplaced liquid hinders and may totally obstruct the supply of reactant gas to local regions of the catalyst. As a result there is an increase in electrode polarization as the non-flooded regions of the electrode are forced to carry more current. The process is self-propagating and will eventually lead to cell failure. In fuel cells having an acid electrolyte the flooding phenomenon is most prevalent at the cathode i.e., at the water-producing electrode. (See WO/1993/003505) High Current Acid Fuel Cell Electrodes.)

See also, EP0046086: "Early in the development of electrodes for fuel cells it was realised that porous, hydrophobic electrodes were desirable especially for use as a hydrogen anode in order to achieve proper control of electrode wetting and to prevent flooding thereof by the electrolyte so that both the reaction gases and the electrolyte had satisfactory access to the electro-catalyst in the electrode."

> The electrodes comprise gas absorbing metal particles bonded together into a cohesive mass with polytetrafluoroethylene and having a coating of polytetrafluoroethylene bonded to the electrode surface in contact with the gas phase. These novel electrode structures, when used in combination with the aqueous electrolyte ... do not require special fabrication or additional precautions to prevent the electrolyte from flooding the surface of the electrode in contact with the gas phase, and thereby "drowning" the electrode which would deleteriously affect the performance of the fuel cell reaction." (Col. 1, lines 19-30.)

Thus, Dempsey discloses (via its citation to Niedrach and its repeated express disclosure that the electrode binder is hydrophobic) that its electrodes are impervious to the water such that flooding/drowning of the electrode does not occur.

In sum, Dempsey teaches the necessity that the counter electrode be surrounded with distilled liquid water in order to keep the membrane and the ionically conducting bridge on the membrane hydrated. Dempsey further teaches the necessity that the electrode be hydrophobic so that drowning of the electrode in the aqueous environment does not occur.[2]

Uchida, Grot and Vanderborgh

The Examiner has cited to Uchida, Grot and Vanderborgh because each of these references teach, in the context of fuel cells and/or electrolytic cells, the addition of Nafion® to an electrode composition.

However, a person of ordinary skill in the art at the time of the invention would have known that the addition of Nafion® to an electrode composition would make the electrode non-hydrophobic. For example, US 5,599,638 to Surampudi et al. (filed October 12, 1993, and thus indicative of the knowledge of a person of ordinary skill in the art at the time of the invention) discloses that two major categories of electrodes exist: gas-diffusion type electrodes and liquid-feed type electrodes (col. 2, lines 35-48). Surampudi discloses

[2] Further, with respect to the Examiner's assertion that Dempsey recognizes that electrodes set forth in the fuel cell prior art would find utility in the sensor of Dempsey (citing to col. 8, lines 30-63, as justification for citing to Uchida, Vanderborgh or Grot), Applicants submit that this recognition by Dempsey of fuel cell prior art electrodes is limited to ***hydrophobic*** electrodes, such as those taught by Niedrach.

that electrodes formed of carbon-supported alloy [catalyst] powder and a Teflon® binder yield a gas diffusion electrode (col. 2, lines 25-27). According to Surampudi, gas-diffusion type electrodes, which have poor fuel wetting properties, can be modified for use in liquid feed cells by including substances that improve their wetting properties, *e.g.*, Nafion® (col. 4, lines 10-21). Surampudi discloses that the addition of Nafion® to an electrode composition allows the liquid surrounding the electrode to flow into or wet the pores, thus creating a liquid-feed type electrode. In other words, Surampudi teaches that electrodes having poor wetting properties (*i.e.*, hydrophobic electrodes) can be converted to electrodes having good wetting properties (*i.e.*, non-hydrophobic electrodes) by the addition of Nafion®.

Thus, Uchida, Grot and Vanderborgh, by disclosing the addition of Nafion® to the electrode compositions, all disclose liquid-fuel type electrodes, i.e., electrodes that will allow water to penetrate their pores.[3]

<u>Uchida</u>

Uchida fails to disclose electrodes having the claimed composition, i.e., a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

Example 1 of Uchida discloses that 1g of Nafion® polymer was added to 60g of n-butyl acetate to form a colloidal dispersion. Then 50g of Pt-C (having 10-25% platinum catalyst) were added to this colloidal dispersion. The resulting paste was coated on carbon paper. Thus, the disclosed electrode of example 1 has 2.0 wt% proton conductor material (1g Nafion®/ (1g Nafion® + 50g Pt-C)) and 98 wt% electrical conductor material (50g Pt-C / (1g Nafion® + 50g Pt-C)).

Examples 2-6 maintain the same solids ratios, merely swapping out the organic solvents.

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[3] A liquid-fuel type electrode can be used in a non-liquid environment and operated as a gas-diffusion electrode. However, if a liquid-fuel type electrode is used in a liquid environment, it cannot then operate as a gas-diffusion electrode, as its pores will be flooded.

Example 7 adds an additional 25g of carbon powder (having 25-70 wt% PTFE) to the colloidal dispersion. Thus, the disclosed electrode of example 7 has 1.3 wt% proton conductor material (1g Nafion®/ (1g Nafion® + 50g Pt-C + 25g C/PTFE)) and 75.7 wt% to 90.4 wt% electrical conductor material ((50g Pt-C + 30% to 75% of (25g C/PTFE)) / (1g Nafion® + 50g Pt-C + 25g C/PTFE)).

Thus, while the claims require 10-50 wt % of a proton conductor material, none of the inventive examples of Uchida have a wt % of Nafion® that exceeds 2.0 wt %.

Uchida's comparative example is disclosed at col. 7, line 54 to col. 8, line 7. Uchida's comparative example does not explicitly disclose the amounts of the Pt-C component (10-25 wt% platinum) or of the C/PTFE component (25-70 wt% PTFE). Uchida discloses that the Pt-C and the C/PTFE are sprinkled on carbon paper and hot pressed to form an electrode. This hot pressed Pt-C with C/PTFE layer does not include a proton conductor material.

At the top of col. 8, in a new paragraph, Uchida discloses that a *coat* of Nafion® is applied to the previously hot-pressed catalyst layer of the electrode. In other words, in the comparative example, Uchida discloses that the Nafion® coat is a separate layer formed on the electrode after the electrode has been hot pressed. This separate Nafion® layer does not include any electrical conductor material.

Thus, with respect to the comparative example, Uchida fails to disclose any material having a proton-electron mixed conductive material. Rather, Uchida discloses two material layers: the hot pressed Pt-C with C/PTFE layer (and with no proton conductor material) and the Nafion® layer (with no electrical conductor material). These two distinct layers do not form a single proton-electron mixed conductive material as required by the claims of the instant application.

And, in fact, this is exactly the point of Uchida's comparative example—to compare the separate Nafion® and carbon layers of the comparative example to Uchida's inventive examples, which have a low level of Nafion® mixed in with the electrical conductor material. Given this, it is irrelevant what weight percent this separate Nafion® proton conductive layer has relative to the Pt-C with C/PTFE electron conductive layer.

Thus, neither Uchida's inventive examples (Examples 1-7) nor Uchida's comparative example disclose a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material.

Vanderborgh

Vanderborgh fails to disclose electrodes having the claimed composition, i.e., an electrical conducting material that is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

Vanderborgh discloses that an object of the invention is to provide a composite electrode which is constructed to have increasing electronic conductivity from the catalyst loading zone to a current collector on one face of the electrode, and to have increasing protonic conductivity from the zone of the catalyst loading to the face of the electrode which engages the ion exchange membrane. (Col. 3, lines 37-44).

Vanderborgh accomplishes this by providing an electrode comprised of three zones or layers. Referring to FIG. 2, Vanderborgh discloses that the composite electrode is formed of three separate layers (22, 24 and 26) thermally bonded to each other (col. 8, lines 13-15; col. 8, lines 59-62). Each layer comprises a mixture of carbon black, platinum, PTFE and a suitable ionic conducting material (col. 8, lines 16-20).

Table I discloses the compositional parameters for each layer. Layer 22 has a proton conducting material weight percent of 4.3% (.021/.491) and an electrical conducting material weight percent of 82.3% (.304/.491). Layer 24 has a proton conducting material weight percent of 4.4% (.119/2.718) and an electrical conducting material weight percent of 91.2% (2.48/2.718). Layer 26 has a proton conducting material weight percent of 74% (.422/.570) and an electrical conducting material weight percent of 12.1% (.069/.570). None of these layers has 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material, as required by the claims.

Further, it would be improper to considered the entire composite electrode of Vanderborgh as a single electrical conducting material, i.e., to consider the three separate

layers 22, 24, 26 to be a single material. Each separate layer of the electrode is a distinct material—bonding the layers together does not form a new "material."

Grot

In the example referred to by the Examiner, Grot discloses using a non-hydrophobic binder (Nafion®) for its fuel cell electrode (col. 14, lines 15-27). In addition to the teachings of Surampudi, discussed above, (i.e., that the addition of Nafion® to an electrode composition creates a non-hydrophobic, liquid-fuel type electrode), Grot expressly discloses that the electrode is a "gas-***liquid*** permeable porous electrode." (Col. 1, lines 31-32; emphasis added.) Thus, Grot explicitly discloses that its electrode is a liquid-fuel type electrode, i.e., an electrode that is specifically designed to allow the penetration of the liquid into the pores of the electrode.

Grot further explicitly discloses that its membrane and electrode structure is useful in electrolytic cells where, for example, the anode electrolyzes an aqueous solution. Thus, again Grot discloses that the electrode may be a liquid-fuel type electrode (col. 13, lines 35-50).

b. The Proposed Combination of References Changes Dempsey's Principle of Operation and, in fact, Renders Dempsey Unsatisfactory for its Intended Purpose

The Examiner has indicated that it would have been obvious to utilize the teachings of Uchida, Grot and/or Vanderborgh for the sensor of Dempsey. Applicants disagree.

If one were to replace the hydrophobic electrodes, as expressly taught by Dempsey, with non-hydrophobic electrodes as taught by Grot (or Uchida, or Vanderborgh), Dempsey's principle of operation would be changed. In fact, Dempsey would be rendered inoperable or, at the very least, unsatisfactory for its intended purpose due to flooding of the electrodes of Grot (or Uchida, or Vanderborgh).

Dempsey teaches a gas sensor that uses a gas permeable (i.e. a gas-diffusion type) electrode. However, Dempsey also teaches surrounding the area of the counter electrode with distilled liquid water. Dempsey then further explicitly and repeatedly teaches using a hydrophobic binder for the electrodes. (Col. 8, lines 34-44.) Niedrach (cited by Dempsey

to disclose the electrodes used in the gas sensor of Dempsey and the process of making these electrodes) explicitly teaches using hydrophobic electrodes so that the electrodes will not "drown" in an aqueous environment (col. 1, lines 19-30). In essence, Dempsey teaches away from using a non-hydrophobic binder for the electrodes.

Uchida discloses including a non-hydrophobic binder (Nafion®) in its fuel cell electrodes.

Vanderborgh discloses including a non-hydrophobic binder (Nafion®) in its fuel cell electrodes.

Grot discloses including a non-hydrophobic binder (Nafion®) in its fuel cell electrodes.

Surampudi teaches that the inclusion of Nafion® in the electrode composition converts a gas-diffusion type electrode into a liquid-fuel type electrode.

A person of ordinary skill the art would realize that replacing Dempsey's gas-diffusion type, hydrophobic electrodes with a liquid-fuel type electrode as taught by Grot (or Uchida, or Vanderborgh) would result in the electrodes being flooded/drowned with the distilled water, such that the gas to be reacted would be unable to reach the reaction sites within the electrodes. (See discussion of Surampudi, above.) In essence, Dempsey's gas sensor would be unable to sense or react to the gas. Thus, contrary to the Examiner's assertion, as the combination renders Dempsey's sensor inoperable, one of ordinary skill in the art would have reason to NOT replace the hydrophobic electrodes of Dempsey with the non-hydrophobic electrodes of Grot (or Uchida, or Vanderborgh).

i. Claims 79, 81, 86 and 88

Claims 79, 81, 86 and 88 stand rejected over Dempsey et al. (US 4,277,984) in view of Nagata et al. (US 4,913,792) and any of Vanderborgh et al. (US 4,804,592), Uchida et al. (US 5,474,857) and/or Grot et al. (US 5,330,860). Applicants traverse these rejections as follows.

As an initial matter, as discussed above, Dempsey teaches away from using an electrode as taught by Grot (or Uchida, or Vanderborgh), and further combining Grot (or Uchida, or Vanderborgh) with Dempsey would render Dempsey inoperable.

Nagata, a newly cited reference, is relied upon by the Examiner for allegedly teaching that two-electrode and three-electrode gas sensors were known in the art and that sensors were readily transferable between the two (OA, p. 6). The Examiner asserts that Nagata teaches that the reference electrode used to stabilize the portion of the working electrode is not necessary as long as the counter electrode is large enough to help maintain a stable potential at the working electrode.

Applicants assert that Nagata's disclosure as to eliminating a reference electrode is not relevant to Dempsey's sensor, and in particular, is not germane to Dempsey's disclosure concerning its reference electrode. Specifically, *Dempsey uses its reference electrode to account for* <u>*temperature variations during zero-air operations*</u>, whereas *Nagata uses the reference electrode to account for a* <u>*drifting counter electrode potential due to the reduction/oxidation reactions*</u>. Nagata's reference electrode is not used to account for temperature variations. Thus, it is improper to apply Nagata's teaching of a sensor without a reference electrode to Dempsey's temperature invariant sensor. At the very least, Nagata's disclosure that two-electrode sensors may be commensurate with three-electrode sensors under certain operating conditions and functional requirements, is not applicable to Dempsey where the functional requirements differ from Nagata's. Indeed, if one were to eliminate the reference sensor from Dempsey, as taught by Nagata, Dempsey's sensor would no longer be operative for its disclosed purpose—i.e., stable zero-air operation under changing temperature conditions.

Specifically, Dempsey discloses that a reference electrode 11 is provided on the same surface as the sensing electrode to eliminate large background current variations with *temperature variations* during zero-air operations. *See*, Title; col. 1, lines 24-37; col. 2, lines 6-13; col. 4, lines 11-29; col. 4, line 67 – col. 5, line 5; and col. 6, lines 10-12 and lines 30-37. The reference electrode is positioned as close as possible to the sensing electrode, while being maintained remote from the flux lines between the sensing and

counter electrodes, *so that the reference and sensing electrodes may be subjected to the same temperature conditions.* Col. 4, lines 11-29 and col. 6, lines 10-12. Specifically, Dempsey uses a potentiostatic circuit to maintain the potential of the sensing electrode at a desired level and to maintain a fixed potential difference between the sensing electrode and the reference electrode to permit invariant and accurate operation with time and *with changes in temperature*. Col. 4, line 67 – col. 5, line 5.

In contrast, Nagata discloses a reference electrode t*o maintain the potential at the surface of the working electrode, in order to account for a change in the potential of the counter electrode due to the oxidation and reduction reactions taking place*. Col. 5, line 65 – col. 6, line 12. Nagata does not disclose the use of a reference electrode to maintain the potential of the working electrode to account for changes in temperature. As Nagata uses a reference electrode for a different purpose than Dempsey uses a reference electrode, Nagata's disclosure that the reference electrode need not be used under certain conditions is inapposite to Dempsey's disclosure.

Further, significant differences in the functionality and the arrangement of the sensors preclude applying the teachings of Nagata to Dempsey. For example, Dempsey discloses a hydrated gas sensor for operation from 1°C to 40°C. In contrast, Nagata discloses a flammable gas sensor for operation from 100°C to 400°C. Also, Dempsey discloses that the sensing electrode 13 and the counter electrode 10 are arranged on opposite sides of the hydrated solid polymer electrolyte membrane and spatially aligned with one another. In contrast, Nagata discloses that the working electrode 2, the counter electrode 4 and, optionally, the reference electrode 3 are provided on a surface of an insulating substrate 1 and covered by a gas-permeable proton-conductive film 5. Nagata, thus, discloses that each of its electrodes is arranged on the *same side* of the gas-permeable proton-conductive film.

As the Examiner has recognized that Dempsey fails to disclose that the sensing electrode and the counter electrode are the only two electrodes, and as Nagata, as discussed above, fails to disclose that the reference electrode of Dempsey could be eliminated without disrupting the principle of operation of Dempsey, the combination of Dempsey in

view of Nagata fails to render claims 79, 81, 86 and 88 unpatentable. Further, as none of Vanderborgh, Uchida or Grot discloses two-electrode sensors, Vanderborgh, Uchida and Grot fail to cure the deficiency of Dempsey in view of Nagata.

For all the above reasons, the subject claims are patentable over the applied citations.

ii. Claims 79-94

Claims 79-94 stand rejected over Tomantschger et al. (US 5,173,166) in view of Dempsey and any of Vanderborgh, Uchida and/or Grot. Applicants traverse these rejections as follows.

As an initial matter, as discussed above, Dempsey teaches away from using an electrode as taught by Grot (or Uchida, or Vanderborgh), and further combining Grot (or Uchida, or Vanderborgh) with Dempsey would render Dempsey inoperable.

Applicants submit that it is improper to combine Tomantschger '166 with Vanderborgh, Uchida and/or Grot. Specifically, with respect to its electrodes, Tomantschger '166 discloses:

> In keeping with the invention, the porous sensing electrodes used in the electrochemical sensing cells discussed above comprise a layer which contains a catalytically active metal—usually a noble metal—together with carbon and a polymeric hydrophobic binder, all in a suitable substrate.
>
> ...
>
> The polymeric binder may be any suitable inert resin, particularly a hydrophobic component. Examples of such binders include polyethylene, polypropylene, polyvinylchloride, polystyrene, and PTFE. ...

Col. 11, lines 26-53. Tomantschger '166 expressly teaches that its electrodes are formed with a polymeric binder that is an *inert* resin. Thus, Applicants submit that it is improper for the Examiner to conclude that the electrodes of Vanderborgh, Uchida and/or Grot, which include *Nafion, a non-inert, ionically-conductive polymeric binder*, could be simply substituted into the sensor of Tomantschger '166. The compositions of the electrodes of Vanderborgh, Uchida and Grot are at odds with the express teachings of Tomantschger '166. Further, any generalized teachings within Vanderborgh, Uchida and Grot that their

electrodes are superior to prior art electrodes, are not sufficient to overcome the explicit teachings of Tomantschger '166 to use an electrode formed with a polymeric binder that is an inert resin.

Even further, according to the Examiner, Tomantschger '166 does not explicitly disclose a particular diameter for its electrodes or a particular thickness of protonic conductive electrolyte membrane. The Examiner relies on Dempsey for its disclosure of sensing and counter electrodes having a diameter of 16 mm and a Nafion® membrane thickness of .3 mm. The Examiner asserts that it would have been obvious to use the electrode and electrolyte (sic, membrane) dimensions of Dempsey for the dimensions of Tomantschger '166. Applicant disagrees.

The absence of any disclosure in Tomantschger '166 as to electrode diameters or membrane thicknesses, does not lead one to conclude that *any* dimensions disclosed in art cited by Tomantschger '166 could be utilized. In fact, Nagata, cited by the Examiner and discussed above, explicitly discloses that the dimension of a counter electrode for a three-electrode sensor (e.g., FIG. 1) is different than the dimension of a counter electrode for a two-electrode sensor (FIG. 8).

For example, Nagata discloses that when a reference electrode is eliminated from a three-electrode sensor, for certain functionalities and under certain operating conditions, commensurate performance of the three-electrode sensor may be achieved if the area of the counter electrode in the two-electrode sensor is ten or more times (and preferably 100 times) as large as the sensing electrode.

Thus, at the very least, Nagata teaches that Dempsey's disclosure as to dimensions of components of a three-electrode sensor does not provide any teachings, and is thus irrelevant, as to any dimensions of components of a two-electrode sensor, such as disclosed by Tomantschger '166.

As it is improper to combine Tomantschger '166 with Vanderborgh, Uchida or Grot, with respect to the composition of the electrodes, and as it is further improper to combine Tomantschger '166 with Dempsey with respect to the dimensions of the sensor

components, claims 79-94 are not rendered unpatentable over the asserted combination of references.

iii. Claims 80, 82, 84, 87, 89, 91, 92 and 94

Claims 80, 82, 84, 87, 89, 91, 92 and 94 stand rejected over Dempsey in view of any of Vanderborgh, Uchida and/or Grot.

As presented above (see infra p.40), Applicants submit that a person of ordinary skill the art would realize that replacing Dempsey's gas-diffusion type, hydrophobic electrodes with a liquid-fuel type electrode as taught by Grot (or Uchida, or Vanderborgh) would result in the electrodes being flooded/drowned with the distilled water, such that the gas to be reacted would be unable to reach the reaction sites within the electrodes. (See discussion of Surampudi, above.) In essence, Dempsey's gas sensor would be unable to sense or react to the gas. Thus, contrary to the Examiner's assertion, as the combination renders Dempsey's sensor inoperable, one of ordinary skill in the art would have reason to NOT replace the hydrophobic electrodes of Dempsey with the non-hydrophobic electrodes of Grot (or Uchida, or Vanderborgh).

Further, claim 80 includes the recitation of "the sensing electrode reacting with the gas to produce a change in an electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode." Claims 84, 87, 91 and 94 include similar recitations. Claim 92 recites "in the absence of any biasing voltage."

The Examiner has indicated that the electrode of Dempsey in view of Vanderborgh, Uchida and/or Grot would inherently be capable of reacting with a gas in the absence of an applied voltage to the sensing electrode. Applicants traverse these rejections as follows.

A finding of inherency requires that the missing descriptive matter is necessarily present. Inherency may not be established by probabilities or possibilities. The mere fact that a certain thing may result is not sufficient. MPEP 2112(IV). Further, in relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic

necessarily flows from the teachings of the prior art. *Id.* Applicants submit that the Examiner has not provided such a basis. Nor is any reason apparent to Applicant as to why Dempsey in view of the secondary citations could necessarily be capable of reacting with a gas in the absence of an applied charge to the sensing electrode. Furthermore, as to obviousness, obviousness cannot be predicated on what is not known at the time the invention was made, even if the inherency of a certain feature is later established. MPEP 2141.02(V).

Indeed, Dempsey expressly teaches that "the voltage [of the sensing electrode] should not be allowed to fall below approximately 1.0 volts in order to maintain an oxide coating on the surface of the catalytic sensing electrode to prevent CO poisoning of the electrode and to prevent reduction of oxygen at the electrode or other competing reactions which introduce error currents." Col. 10, lines 3-9. In other words, *Dempsey expressly teaches that its sensor electrode would be poisoned by CO in the absence of a maintained voltage of 1.0 or greater.* In light of this express teaching and in the absence of any teaching as to why the electrodes of Vanderborgh, Uchida and/or Grot would not be poisoned by CO, it appears that the electrode of Dempsey in view of Vanderborgh, Uchida and/or Grot would <u>not</u> inherently be capable or reacting with a gas in the absence of an applied voltage to the sensing electrode.

Accordingly, Applicants submit that claims 80, 84, 87, 91, 92 and 94 are not rendered unpatentable over the asserted combination of references.

Claims 82 and 89 further include the recitation that "the sensing electrode and the counter electrode [are] on opposite sides of the first protonic conductive electrolyte member." For at least the reason that the combination of Grot (or Uchida, or Vanderborgh) with Dempsey would render Dempsey's sensor inoperable, such that one of ordinary skill in the art would have reason to NOT replace the hydrophobic electrodes of Dempsey with the non-hydrophobic electrodes of Grot (or Uchida, or Vanderborgh), Applicants submit that claims 82 and 89 are also allowable. Newly presented claims 98-113 and amended claims 2, 17, 18 and 27 depend directly or indirectly from claim 82 and contain additional

recitations thereto. Thus, Applicants respectfully submit that these claims are also patentably distinguishable from the cited references.

iv. Claims 83, 85, 90 and 93

Claims 83, 85, 90 and 93 stand rejected over Dempsey in view of any of Vanderborgh, Uchida and/or Grot and further in view of Nagata.

As an initial matter, as discussed above, Dempsey teaches away from using an electrode as taught by Grot (or Uchida, or Vanderborgh), and further combining Grot (or Uchida, or Vanderborgh) with Dempsey would render Dempsey inoperable. Nagata fails to cure these deficiencies

The Examiner has asserted that it would have been obvious to utilize only two electrodes for the sensor of Dempsey as taught by Nagata. Applicants disagree, and as presented above, have shown that the teachings of Nagata concerning any substitution of a two-electrode sensor for a three-electrode sensor is not applicable to the three-electrode temperature-stabilized sensor of Dempsey.

Accordingly, Applicants submit that claims 83, 85, 90 and 93 are not rendered unpatentable over the asserted combination of references.

VIII. Newly Presented Evidence of Commercial Success

Submitted with Applicants' Response dated September 22, 2008, was Applicants' Supplemental Declaration of Commercial Success Under 37 CFR §1.132 (referred to herein as the "Dr. Shen's Supplemental Declaration" or the "Supplemental Declaration"). This declaration, signed by Dr. Yousheng Shen, one of the named inventors of the '648 Patent, presents substantial new evidence that the invention described and claimed in the '648 Patent has been highly successful in the marketplace. In addition, the declaration sets forth a detailed explanation of the significant advantages of the claimed invention over the prior art, including the references cited against this group of claims.

In the '208 Reexam, the Examiner held, and the Board agreed, that Dempsey teaches all of the limitations then recited in original Claim 1, except that Dempsey fails to

teach the use of mixed ionic-protonic conductive electrodes. The Examiner cited Grot, Uchida and Vanderborgh as teaching the use of electrodes having the claimed combination of proton conducting material and electron conducting materials. Applicants respectfully request reconsideration based on the amendments above, the above-presented technical understanding of Dempsey, Grot, Uchida and Vanderborgh, and the newly available objective evidence of nonobviousness.

Even after the Supreme Court's *KSR* decision, a determination of obviousness requires adherence to the following tenets: (1) the claimed invention must be considered as a whole; (2) the references must be considered as a whole and must suggest the desirability and thus the obviousness of making the combination; (3) the references must be viewed without the benefit of impermissible hindsight afforded by the claimed invention; and (4) reasonable expectation of success is the standard with which obviousness is determined. See *Hodosh v. Block Drug Co., Inc.*, 786 F.2d 1136, 1143 n.5, 229 USPQ 182 187 n.5 (Fed. Cir. 1986). Even though the Board has characterized the teachings of the cited references as not limited to the non-analogous field of fuel cells, application of the proper obviousness standard does not lead to the conclusion that one of skill in the art at the time the invention was made would be prompted to combine these references in order to make the invention defined by the amended claims.

On appeal in the '208 Reexam, the Board sustained the Examiner's argument that Dempsey discloses all of the limitations of original Claim 1, except for the use of electrodes having the claimed electron conductive mixed material and proton conducting material. (Decision at p. 23). The Board also agreed with the Examiner's conclusion that one of skill in the art would be motivated to combine the proton-electron mixed conductive electrodes described in Grot and Uchida in the sensor of Dempsey. (*Id.* at 24). Finally, the Examiner stated that substitution of the electrodes of Vanderborgh would not have provided unexpected results and, therefore, would have required only routine skill in the art. (*Id.*)

However, at the very least, the Supplemental Declaration, which constitutes substantial new objective evidence of nonobviousness, was not considered by the Board

and contradicts this conclusion. This new evidence was not available prior to the briefing of the appeal, and only became available during the pendency of the appeal. This new objective evidence of commercial success, involves, in large part, sales of sensors within the scope of the subject claims during the time period following close of ex parte prosecution prior to the appeal. Applicants' attempt to introduce this evidence for consideration by the Board was not allowed.

As noted in sections 9 and 10 of Dr. Shen's Supplemental Declaration, commercial embodiments of the claimed invention manufactured by Atwood's licensee under the '648 patent exhibit many improvements over prior art CO sensors, including: reliable operation at room temperature; no need to recalibrate; no power consumption for the sensors, themselves; improved CO detection accuracy; and lower cost of manufacture. These commercial advantages are made possible by the following technical performance properties described in the '648 Patent:

a. minimal ionic (H^+) resistance between the electrodes without significant diffusion of contaminating hydrogen molecules;

b. rapid response to CO in ambient air;

c. strong current signal output in response to detection of CO;

d. no need for periodic re-calibration of the sensor;

e. use of a solid electrolyte, resulting in reduction/elimination of background drift or countersignal caused by contamination of electrolyte or the water vapor source;

f. avoidance of long term stability problems in prior art devices;

g. short ion path and solid state protonic and ionic conductivity, eliminating the need for the reference electrode and amplifier (and the resulting need for applied DC power to drive the detection current) in the prior art; and,

h. continuity in transport of electrical charges to avoid polarization effects at the electrodes.

These properties are all interrelated and result from the inventive geometry and selection of materials described in the '648 Patent and recited in the subject claims.

In section 10 of Dr. Shen's Declaration, Dr. Shen relates these technical improvement properties to the recitations of the claims. As examples, claims 82 and 97 recite: a protonic conductive electrolyte membrane being in between and in contact with the sensing and counter electrodes, and having a thickness in the range of approximately 0.1 mm to 1 mm. The electrolyte membrane can be of a minimum thickness and yet still sufficient to prevent significant diffusion of contaminating CO molecules through the membrane to the counter electrode. This optimized free ion path results in a stronger current, eliminating the need for either a signal amplifier or a reference electrode.

Further, the use of a proton conductive membrane instead of a liquid electrolyte reduces the prior art need for re-calibration due to liquid contamination, which would cause drift of the output signal. Prior art sensors often required the use of a reference electrode and a bias source to counter this unwanted effect.

Claims 82 and 97 also recite that this electrolyte membrane is in combination with:

> porous mixed ionic-electronic conductive sensing and counter electrodes having both an electronic conducting material and an ionic conducting material.

When combined with the claimed electrolyte membrane, this recitation results in minimal ionic (H^+) resistance between the electrodes without significant diffusion of contaminating gas molecules and a short ion path. This leads to the rapid response at room temperature in ambient air, the strong signal current in response to detection of the gas, and the avoidance of polarization. Further, the reduction in background drift, the elimination of any need for periodic re-calibration of the sensor, the avoidance of long term stability problems, and the elimination of any need for a reference electrode are direct consequences of using a solid electrolyte having a thickness range as claimed with the mixed ionic electronic conductive electrodes as claimed.

As the claims' recitations directly result in every single technical performance property listed in the declaration, a nexus between commercial success and the claimed invention has been proven.

Further, there is no indication in the cited references, taken alone or as combined by the Examiner, that these advantages of the present invention would or could be obtained by the selective substitutions alleged to re-construct the claimed invention from those references. For example, none the cited references suggest, alone or in combination with the other cited references, the short ion path and solid state protonic and ionic conductivity (advantages "a," "e," and "g" in the list of section (i)) of the presently claimed invention, which eliminates the need for a reference electrode. Thus, none of the cited references enable the commercial advantages of the presently claimed sensor because they do not achieve, either alone or in the combinations set forth, the technical advantages described above. Indeed, in contrast to the established commercial success of the present invention, there is no evidence of record that the sensor of any of the cited references has ever been commercialized successfully. Accordingly, Applicants submit that the foregoing strong objective evidence of non-obviousness applies with full force to all the claims of this Reissue application.

Applicants' amendments have further clarified that the invention of the '648 Patent is directed to low cost, room temperature gas sensors, and not to fuel cells. Applicants' showing of strong commercial success, owing to the achievement of significant technical advantages by the claimed sensor structure, which advantages were not predictable from the combinations of references applied by the Examiner establish that the invention as now claimed is not obvious.

Further, Dr. Shen's Supplemental Declaration notes that the '648 Patent (and another closely-related patent currently undergoing re-examination) are the subject of a royalty-bearing license agreement entered into in June, 1998. The license is an arms-length agreement between separate corporate entities. Pursuant to the license, Atwood (the assignee of the '648 Patent) has received royalty payments and royalty reports based on the number of sensors sold by the licensee. (See Dr. Shen's Supplemental Declaration at section 11). The licensed product was immediately successful, achieving sales of 1,991,639 units in 1999, the first full year under the license agreement. Sales continued to

grow thereafter, reaching 2,717,913 units in 2001. (Dr. Shen's Supplemental Declaration at section 12). This was the extent of the sales information available at the time of briefing of the appeal in the '208 Reexam.

Sales of the licensed product continued to skyrocket in the years of the appeal pendency in the '208 Reexam. Dr. Shen's Supplemental Declaration sets forth the data unavailable during the appeal period showing that, from 2002 through 2006, total royalty payments under the license agreement amounted to over $3.9 million. (*Id.* at paragraph 10). Dr. Shen confirms in his declaration that the licensee's licensed CO Sensor product embodies the limitations of at least Claim 82 and Claim 97 of the '648 Patent. (*Id.* at section 8).

It is well established that commercial success is relevant in resolving the issue of non-obviousness. *Lindenmann Maschinenfabrik GMBH v. American Hoist & Derrick Co.*, 730 F.2d 1452, 221 USPQ 481 (Fed. Cir. 1984). It is also well established that licensing activity, *e.g.*, licensing agreements, is an indicator of non-obviousness. All objective evidence must be properly considered in determining whether claims are non-obvious.

It is clearly evident that the commercial success of the patented CO Sensor product sold pursuant to the license agreement is directly attributable to the advantageous features set forth above, and particularly the advantages of reliable operation at room temperature, without need for recalibration or frequent battery changes, and reduced cost of manufacture, as described and claimed in the '648 Patent. (Dr. Shen's Supplemental Declaration at sections 9 and 10).

In view of the strong objective evidence of commercial success and significant advantages achieved over the prior art, Applicants' respectfully submit that the pending claims in this Reissue application are all patentable over the art of record.

IX. Conclusion

Each of claims presented herein is directed to subject matter that was originally disclosed but never claimed. Applicants respectfully request consideration of all the claims.

If any fees are required for entry of this response, the Director is authorized to debit Deposit Account No. 19-0733, accordingly.

Respectfully submitted,

Dated: January 13, 2009

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